

Comparison of species diversity between *Larix gmelini* pure forest and *Larix gmelini*--*Betula platyphylla* mixed forest in Daxing'an Mountains

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Abstract: Based on the investigation data about the species diversity in Daxing'an Mountains, the difference of species diversity indexes between *Larix gmelini* forest and *Larix gmelini*--*Betula platyphylla* forest was analyzed by the Simpson index (*D*), Shannon--Wiener index (*H'*), Pielou index (*J_{sw}* & *J_{si}*), Alatalo index (*E_a*) and Species richness index (*S*). The result showed that the species diversity index of *Larix gmelini*--*Betula platyphylla* forest was much higher than that of *Larix gmelini* forest in this region. And *Larix gmelini*--*Betula platyphylla* forest was beneficial to maintain the species diversity in Daxing'an Mountains region.

Key words: Daxing'an Mountains; *Larix gmelini* forest; *Larix gmelini*--*Betula platyphylla* forest; Species diversity

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Introduction

Larix gmelini forest is one of the most important forest types in Daxing'an Mountains region. When *Larix gmelini* forest is disturbed, *Betula platyphylla* frequently invades it, so these two types of forests are the dominant ones in the region (Chou 1991). The studies of the vegetation in Daxing'an Mountains have been carried out since 1950, but the studies on species diversity in this region have not carried out until 2000. We compared the indexes of species diversity for different forest types by analyzing the investigation data. The results of this study could be used as an instruction for forest management in Daxing'an Mountains.

Methods

Four pairs of vegetation types are selected for comparing their difference in the species diversity, such as (1) Ass. *Herbage*--*Larix gmelini* and Ass. *Herbage*--*Larix gmelini*--*Betula platyphylla*, (2) Ass. *Rhododendron dauricum*--*Larix gmelini* and Ass. *Rhododendron dauricum*--*Larix gmelini*--*Betula platyphylla*, (3) Ass. *Ledum palustre*--*Larix gmelini* and Ass. *Ledum palustre*--*Larix gmelini*--*Betula platyphylla*, (4) Ass. *Vaccinium vitis-idaea*--*Larix gmelini* and Ass. *Vaccinium vitis-idaea*--*Larix gmelini*--*Betula platyphylla* (Chou 1991). The investigation data from the two types of forest at

different plots in this region were collected. The Simpson index (*D*), Shannon--Wiener index (*H'*), Pielou index (*J_{sw}* & *J_{si}*), Alatalo index (*E_a*) and Species richness index (*S*) were used in this study to analyze the data. These indices are expressed as:

Simpson index (Pielou 1975)

$$D = 1 - \sum [N(N-1)/N]$$

Shannon Wiener index (Pielou 1975)

$$H' = - \sum P_i \ln P_i$$

Pielou index (Whittaker 1972)

$$J_{sw} = (- \sum P_i \ln P_i) / \log S$$

$$J_{si} = (1 - \sum P_i^2) / (1 - 1/S)$$

Alatalo index (Hurlbert 1971)

$$E_a = [(\sum P_i^2)^{-1} - 1] / [\exp(-\sum P_i \ln P_i) - 1]$$

Species richness index: *S*-amount of species in a plot.

Where:

N is the important value of the species *i*,

N is the summation of important value of all species in community;

P_i is the relative important value of the species *i*.

Results

Index, Pielou index, Alatalo index and Species richness index of Ass. *Herbage*--*Larix gmelini*--*Betula platyphylla* forest are much higher than those of Ass. *Herbage*--*Larix gmelini*

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forest, so is the same results between Ass. *hododendron dauricum*--*Larix gmelini*--*Betula platyphylla* forest and *Rhododendron dauricum*--*Larix gmelini* forest; Ass. *Ledum palustre*--*Larix gmelini*--*Betula platyphylla* forest and Ass. *Ledum palustre*--*Larix gmelini* forest; Ass. *Vaccinium vitis idaea*--*Larix gmelini*--*Betula platyphylla* forest, and Ass. *Vaccinium*

vitis idaea--*Larix gmelini* forest (Table 1). The species diversity indices, evenness indices and Species richness index of tree layer, shrub layer and herb layer of *Larix gmelini*--*Betula platyphylla* mixed forest are also much higher than those of *Larix gmelini* pure forest in this region (Table 2-4).

Table 1. Comparison of species diversity indexes of four vegetation types

Vegetation types	D	H'	J _{sw}	J _{si}	E _a	S
Ass. <i>Herbage</i> -- <i>Larix gmelini</i>	0.657 25	0.861 045	0.541 991	0.519 131	0.722 361	5.068 089
Ass. <i>Herbage</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.121 289	1.165 688	0.679 265	0.769 342	0.835 157	6.727 405
Ass. <i>Rhododendron dauricum</i> -- <i>Larix gmelini</i>	0.538 294	0.543 397	0.456 881	0.418 633	0.591 613	3.268 244
Ass. <i>Rhododendron dauricum</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.080 254	1.125 407	0.823 392	0.867 944	0.850 985	5.038 266
Ass. <i>Ledum palustre</i> -- <i>Larix gmelini</i>	0.598 656	0.559 058	0.497 664	0.465 607	0.559 229	2.652 552
Ass. <i>Ledum palustre</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	0.812 675	0.780 491	0.791 748	0.796 139	0.806 082	3.671 163
Ass. <i>Vaccinium vitis idaea</i> -- <i>Larix gmelini</i>	0.540 572	0.568 408	0.427 315	0.392 773	0.553 451	3.238 731
Ass. <i>Vaccinium vitis idaea</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	0.890 961	0.872 727	0.813 898	0.833 04	0.834 599	4.002 642

Table 2. Comparison of species diversity indexes of tree layer in four vegetation types

Vegetation types	D	H'	J _{sw}	J _{si}	E _a	S
Ass. <i>Herbage</i> -- <i>Larix gmelini</i>	0.335 634	0.417 201	0.429 04	0.357 362	0.542 475	2
Ass. <i>Herbage</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	0.913 921	0.739 313	0.672 952	0.760 695	0.940 096	3
Ass. <i>Rhododendron dauricum</i> -- <i>Larix gmelini</i>	0.186 585	0.244 847	0.353 24	0.248 78	0.512 067	2
Ass. <i>Rhododendron dauricum</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	0.786 567	0.808 505	0.832 586	0.865 258	0.900 222	3
Ass. <i>Ledum palustre</i> -- <i>Larix gmelini</i>	0.171 017	0.194 362	0.280 406	0.228 023	0.310 856	2
Ass. <i>Ledum palustre</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	0.691 962	0.653 849	0.943 305	0.922 616	0.928 394	2
Ass. <i>Vaccinium vitis idaea</i> -- <i>Larix gmelini</i>	0.148 345	0.201 035	0.290 032	0.197 793	0.478 382	2
Ass. <i>Vaccinium vitis idaea</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	0.705 055	0.662 867	0.956 314	0.940 074	0.943 26	2

Table 3. Comparison of species diversity indexes of shrub layer in four vegetation types

Vegetation types	D	H'	J _{sw}	J _{si}	E _a	S
Ass. <i>Herbage</i> -- <i>Larix gmelini</i>	0.755 053	0.738 736	0.412 296	0.453 032	0.455 745	4.0
Ass. <i>Herbage</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	0.845 633	0.873 321	0.678 333	0.672 345	0.645 521	4.0
Ass. <i>Rhododendron dauricum</i> -- <i>Larix gmelini</i>	1.019 082	0.859 456	0.619 966	0.679 388	0.762 849	4.0
Ass. <i>Rhododendron dauricum</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.293 796	1.141 035	0.859 024	0.887 475	0.866 628	4.0
Ass. <i>Ledum palustre</i> -- <i>Larix gmelini</i>	1.189 247	1.029 321	0.742 498	0.713 548	0.826 619	4.0
Ass. <i>Ledum palustre</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.285 501	1.077 413	0.844 373	0.915 106	0.902 070	5.0
Ass. <i>Vaccinium vitis idaea</i> -- <i>Larix gmelini</i>	1.080 960	1.039 438	0.645 839	0.675 600	0.645 186	5.0
Ass. <i>Vaccinium vitis idaea</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.128 110	1.088 152	0.791 568	0.728 645	0.671 120	6.0

Table 4. Comparison of species diversity indexes of herb layer in four vegetation types

Vegetation types	D	H'	J _{sw}	J _{si}	E _a	S
Ass. <i>Herbage</i> -- <i>Larix gmelini</i>	1.351 198	1.954 879	0.811 101	0.890 066	0.722 361	9.0
Ass. <i>Herbage</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.726 046	2.203 909	0.813 836	0.924 668	0.781 666	15.0
Ass. <i>Rhododendron dauricum</i> -- <i>Larix gmelini</i>	1.278 697	1.269 460	0.652 373	0.745 928	0.692 830	7.0
Ass. <i>Rhododendron dauricum</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.598 437	1.914 522	0.785 276	0.875 700	0.710 234	11.0
Ass. <i>Ledum palustre</i> -- <i>Larix gmelini</i>	1.342 390	1.304 273	0.802 875	0.862 076	0.876 940	6.0
Ass. <i>Ledum palustre</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.412 578	1.457 254	0.979 394	0.945 929	0.986 536	7.0
Ass. <i>Vaccinium vitis idaea</i> -- <i>Larix gmelini</i>	1.352 941	1.357 354	0.675 743	0.781 252	0.645 186	6.0
Ass. <i>Vaccinium vitis idaea</i> -- <i>Larix gmelini</i> -- <i>Betula platyphylla</i>	1.547 226	1.716 642	0.798 441	0.882 472	0.792 955	9.0

Discussion and suggestion

White birch has the ability to quickly colonize the disturbed sites that were originally occupied by *Larix gmelini* when the *Larix gmelini* forest was disturbed. This will lead to *Larix gmelini* forest change into *Larix gmelini*-*Betula platyphylla* forest. Because the species diversity, Evenness and Species richness of *Larix gmelini*-*Betula platyphylla* forest are higher than those of *Larix gmelini* forest, this conversion is beneficial to maintain the species diversity of the forests. Some studies showed that both the richness and diversity of rats in *Larix gmelini*-*Betula platyphylla* forest were more abundant and higher than those of *Larix gmelini* forest (Xu 1998). This is relevant to the high species diversity of *Larix gmelini*-*Betula platyphylla* forest. The *Larix gmelini*-*Betula platyphylla* is not a stable forest type, it is transitional vegetation and will finally restore to *Larix gmelini* forest (Chou 1991). So

high species diversity of a vegetation type doesn't show that the vegetation type is a stable one. Both species diversity and forest succession should be considered in forest management and silviculture.

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